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Paralleling Simulation of Operations Plan Based on Decision Point Controlling

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Abstract

Operational Plan Paralleling Simulation Based on Decision Point Controlling (P2SDPC) can realize the operational plan's dynamic adjusting and cutting impossible branch based on decision point controlling technology. From then on, we can improve the efficiency of operational plan's simulation by the way of paralleling simulation. Thus we can overcome the problem of the simulation's higher complex and lower efficiency cause of multi-factor combination explosion. This provide a road to commander's decision efficiently based on computer aid.

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Keyword: Decision point, operational plan, multi-branches

1. Introduction

The operational plan made by stuff often is a multi-branches plan in the modern battle environment. On one hand, this is caused by the uncertainty of the battle field; on the other hand, there are indeed many possibly operation for the same goal. Once the operational plans had been made, commander will be attention at the plan's feasibility, which plan will be happened mostly and which efficiency is best. Operation

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simulation and evaluation is a proper meaning to testify the operational plan, and provide commander facility to making decision rapidly.

Multi-branches operational plan has a trend to increase explosively because of the commander's decision temporary and the affection of occasion. Such characters of operational plan have risen up the hard and the expend of time of the plan's evaluation. Traditionally operational plan's simulation methods, such as CPR(Core Plan Representation)[1,2], SPAR(Shared Planning and Activity Representation)[3,4], sysML[5] and so on, almost based on static and supposition beforehand, have some characters like the simulated entities coupled closely with computing resource, can't adjust with dynamic situation, usually simulating as a series mode[6]. In fact, these methods essentially divide an operational plan into several different static plans, then simulate one by one serially. This meaning of simulation has poor efficiency, can't compare multi-branches simulation result real-time, so can't fulfill the need of quickly decision aid with closing real dynamic operation.

2. Operational plan paralleling simulation based on decision point controlling (P2SDPC)

Cause of the operational plan's dynamically, we provide a method of decision point control to constraint the amount of possibly branches, that's meaning the route simulated decreased. According to the operational plan's multi-branches, we use parallel simulation technology to realize simulate multi-route once at a time. It can be proved by experiment that P2SDPC can improve the plan simulation's hard and efficiency greatly from the same situation. Hence, P2SDPC provide a road for commander to making decision aiding by computer. The detail as follows:

As shown as figure 1, operational plan's description module based on operational plan's serial of time and the relationship of cause and effect, use the searching method of deep priority, realize the description of multi-branches operational plan. Its output enters into the decision simulation control module. decision simulation control module use simulation scene duplicate and paralleling simulation to realize dynamically multi-branches operational plan's exercise. Its output enters into dynamically multi-branches paralleling simulation thread pool. Thread pool transfers model compute service and simulation compute resource through resource control module to realize paralleling simulation. Its output enters into the simulation result's contrast module. The simulation result contrast module makes sure which plan is the best based on the compare of simulation result.

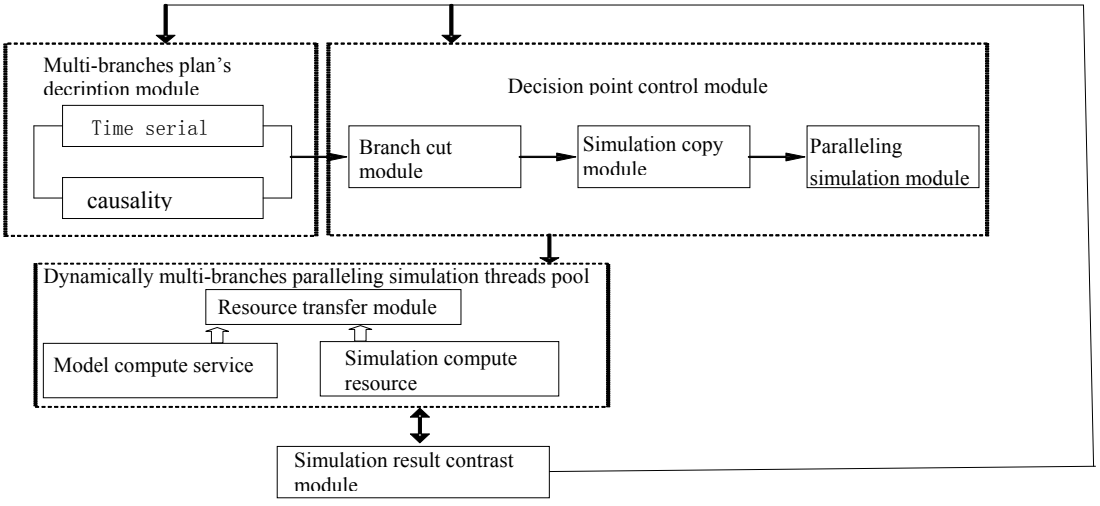

Fig. 1 Operational Plan Paralleling Simulation Based on Decision Point Controlling (P2SDPC)

2.1. Decision point description

A operational plan may be include of many decision points. If there is not decision point at all, then the operational plan is a determinate single branches plan. Operational plan with more than one decision points is multi-branches plan. The decision point can denote as DP and each decision point has many factor of decision. These factors are all dynamically changed with the strength, enemy's state, time, space, resource can be used and target, meanwhile, amount of plan's branches can be choice also changed correspondingly. Decision point can be descripted as follow:

$$D_p = \{Ability, Enemy, Time, Terrain, Space, \mathrm{Re}source, Goal\} \quad (1)$$

Here, Ability means strength, Enemy means enemy state, Time means the time of action, Terrain means terrain environment, Space means battle space, Resources means resource can be used, Goal means the target of fight.

2.2. The process of paralleling simulation based on decision point

Simulation process can be divided into 9 step:

(1) start decision points simulation control module, configure decision points state parameters, inspect whether decision point causing new action branch;

(2) simulate from the first meta-action A0, start main simulation thread;

(3) certainty whether current meta-action's pre-condition pci 's parameters aggregation satisfy constraint.

(4) transfer simulation service model and compute resource, compute resource can be distributed by the plan's branch priority of the current meta-action and system's running state, modify the simulation entity's state and judge whether current meta-action is according with its ending state;

(5) if current simulation meta-action is over, judge whether the branch that meta-action belongs is over. If this branch is over, then active the next meta-action;

(6) if current meta-action is decision point, then modify this decision point's state real-time. Based on the simulation decision point's constraint, if need to enter into new branch, then duplicate the current thread and use this new thread to simulate.

Through the duplicate simulation copy, we can realize multi-branches paralleling simulation. Like these:

(I) judge whether current meta-action is over or broken down;

(II) if no, then execute current meta-action Ai continually.

(III) if yes, then duplicate the current meta-action some copies according to the number of operational plan's branches;

(IIII) each simulation copy simulated to the next meta-action Aj+1， 1≤j≤n independently. That's shown in figure 2:

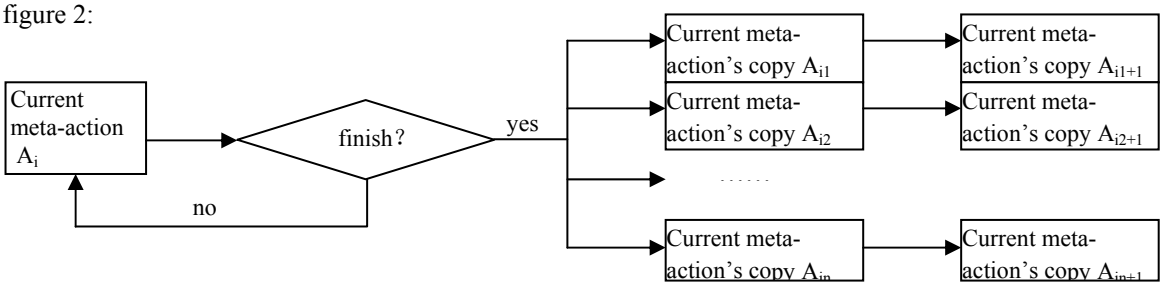

Fig.2 multi-branches paralleling simulation

(7) wipe out the branch impossible. In the process of paralleling simulation, a branch will be over according to situation like such:

(I) a meta-action according with ending condition, but next meta-action's per-condition doesn't satisfied.

(II) according with simulation plan branch's ending condition;

(III) decision point's condition doesn't according with plan branch's start rule;

(IIII) plan branch doesn't according with commander's intent.

(8) the process go along cyclically until the branch simulation is over.

(9) compare the simulation's result

Afer the all possible operational plan's branch are finished, shown the simulated result contrastively, provide commander to choice.

3. Case of operational simulation based on decision point controlling

Here is a case which describes the simulation method. 1st division will attack the enemy who defend on the special location from the current area. There are 2 road for choice, 3 targets to attack. When occupied the first target, army will keep on attacking other target until all the enemy are killed. If the mission finished, the troop will stay on the place for a rest and wait for new operational mission. The operational plan made by commander may be include of the choice of the attacking road and target. So, this is a typical multi-branches operational plan. Such as follow:

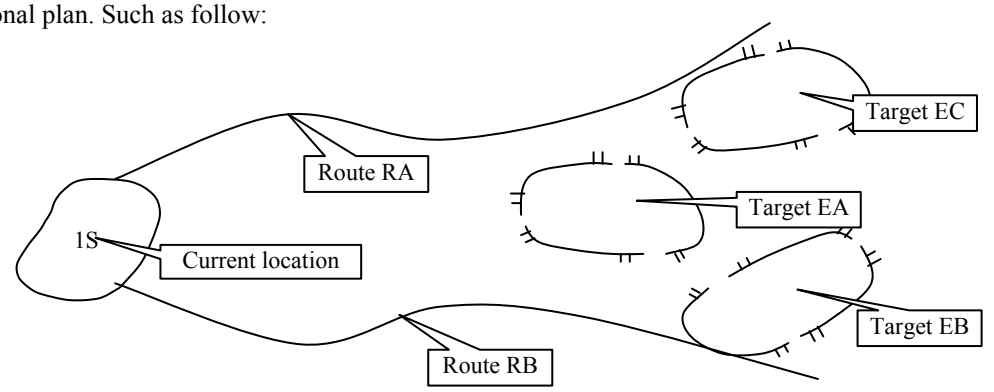

Fig.3 Operation process sketch map

In this case, commander has 2 decision points.

In this case, commander has two decision points, the attacking roads choice D1; and the attacking targets choice D2. If two roads are all clear and three targets will not change in the whole simulation, then the operational plans which supply to commander have four branches.

(1) the operational plan's description as follow:

$$P=\{L_j,\ D_k\} \tag{2}$$

Decision point includes:

D1: make sure the attacking road;

Such conditions should be thinking carefully:{moving capability, enemy state, time used for move, road state, battle space, resource can be used, goal of move}.

D2:make sure the order of target to attack;

Such conditions should be thinking carefully:{strength, enemy state, time used for attack, terrain, battle space, resource can be used, goal of attack}.

Branches include:

Branch L1: attack along the road of RA, first attack target EA, then attack target EB, and last attack target EC;

Branch L2: attack along the road of RA, first attack target EA, then attack target EC, and last attack target EB;

Branch L3: attack along the road of RB, first attack target EA, then attack target EB, and last attack target EC;

Branch L4: attack along the road of RB, first attack target EB, then attack target EA, and last attack target EC;

If in the simulation, decision points' condition have some change, then the branches will changed relatively.

Meta-actions:

Every operational plan's branch has some meta-action. In this case, there are move Am and direct fire Af.

Here gives the description detail.

A) move A_m:

(I) confirm A_m's pre-condition pc_i's parameters aggregation is: {L, P, S}. here, L is the distance between the combat unit and the target; P is the combat unit's strength; S is the combat unit's moving speed.

(II) Confirm pci's constraint condition:

$$\begin{cases} L > 0 \\ P > 0 \end{cases} \tag{3}$$

(III) If all conditions above are met, then the currently action's influence to pc_i's parameters aggregation can be computed: (L-, S), that means the combat unit move at some speed which causes the distance between itself and target decreased.

B) direct fire A_f:

(I) confirm direct fire A_f's pre-condition pc_i's parameters aggregation: {L,R,P,EP,F,S,D}. Here, L is the distance between combat unit and its target; R is the weapon's destroy radii; P is the strength of the combat unit; EP is enemy unit's strength; F is the weapon's fire speed; S is the hit probability; D is the level of target's ready state.

(II) confirm pc_i's constraint condition:

$$\begin{cases} L < R \\ P > 0 \\ EP > 0 \end{cases} \tag{4}$$

(III) If all conditions above are met, then the currently action's influence to pc_i's parameters aggregation can be computed:

$$\begin{cases} (EP-, S) \\ (S+, F) \\ (S-, D) \end{cases} \tag{5}$$

It's mean that if keeping hit probability, then enemy's strength will be decreased; meanwhile, lifting the weapon's fire speed, the hit probability will also be increased; if the level of target's ready state is higher, then the hit probability will be lower.

(2) Multi-branches paralleling simulation based on decision point

Decision point control module duplicates the main thread of operational plan firstly, that means this division moves along two different way paralleling. When movement finished, this division reaches the next

decision point, and simulation thread becomes four. The simulation will continue to attack the target differently until all the simulation threads are finished.

(3) wipe out the branch impossible.

In the process of simulation, if simulation branch can't finish or according with the finish constraints, then this simulation branch should be wiped out, and give the reason and the simulation result. for example that if any simulation branch which battle units' strength has only 50% or even lower, that means the units lost ability of attacking, then this branch will be wiped out.

(4) contrast of the simulation result

parameters / branches	Battle time	Strength lost	score
Branch 1	3 hours	40%	Enemy's strength decrease 60%
Branch 2	3.5 hours	45%	Enemy's strength decrease 65%
Branch 3	2.5 hours	38%	Enemy's strength decrease 65%
Branch 4	2.8 hours	39%	Enemy's strength decrease 67%

That shows that branch 3 is better than others.

4. Conclusion

Operational Plan Paralleling Simulation Based on Decision Point Controlling (P2SDPC) has mainly functions as follows: first, it increase the multi-branches operational plan's simulation efficiency, transfer the asynchronous serial simulation to synchronized paralleling simulation, that supports the commander's multi-branches operational plan's decision real-time; second, it supports the plan's simulation in the dynamically battle field, change the static plan's simulation prepared to dynamic simulation instantly, supports the change of battle field and adjust the simulation branch automatically; third, commander can evaluate and choice the operational plan quickly based on the simulation. So, Operational Plan Paralleling Simulation Based on Decision Point Controlling can realize the commander's rapidly decision with the aid of computer. That provide the base of controlling enemy ahead.

Acknowledgement

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References

[1] Adam R P. Core Plan Representation[R]. Object Model Working Group, 1998.
[2] Pease A. The JTF ATD Core Plan Representation: Request for Comment[R]. Armstrong Lab: AL/HR.TP.96-9631, Wright-Patterson AFB, OH.1996.
[3] Schlenoff C. (ed.), Knutilla A, Ray S. Unified Process Specification Language: Functional Requirements for Modeling Processes[R]. NISTIR 5910, Gaithersburg, Maryland, 1998.
[4] Lee J. Gruninger M, Jin Y, et al. Process Interchange Format and Framework[J]. The Knowledge

Engineering Review, Special Issue on Ontologies(eds. M. Uschold and A. Tate) Cambrige University Press, 1998,13(1):1032-1034.
[5] OMG.SysML–vl.2–PDF.pdf[EB/OL].(2010-06-01), http://www.omg.org/spec/SysML/1.2/.
[6] Foundational Cyberwarfare DARPA-BAA-13-02. 2012.11